SEASONAL SUCCESSION OF CERTAIN INVERTEBRATES IN A NORTHWESTERN FLORIDA LAKE

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Synopsis

Seasonal succession of bottom macro-invertebrates was studied from October 1960 to October 1961 in an attempt to discover the facts of succession in a northwestern Florida lake. Several observed factors influenced invertebrate succession but temperature seemed to be the major cause. As the water temperature fluctuated so did the number of organisms; however, the variety of invertebrates remained relatively constant throughout the year.

Introduction

The affect of seasonal changes on invertebrate organisms in Florida's streams and lakes is a phase of aquatic ecology in which too little investigation has been concentrated. Major contributions to knowledge in this field are by Harkness and Pierce (1941), Sellards (1914), and Pierce (1947) who have described the physical, chemical, and biological conditions that prevail in the waters of peninsular Florida.

Because invertebrate seasonal succession in northwestern Florida waters may differ from that in waters of peninsular Florida it seemed worthwhile to investigate succession in this section of the state. A preliminary study of the standing crop of Lake Cassidy was conducted in June 1960 and from October 1960 to October 1961, a continuous monthly investigation was made. The purpose of this monthly investigation was to determine seasonal succession of bottom invertebrates. This was accomplished by studying selected environmental factors involved in seasonal succession and attempting to discover their relative values.

Description of the Lake

Lake Cassidy is a 220 acre lake which has been relatively undisturbed since a fish population study in September, 1957 (Byrd and Wilson). The lake is in western Holmes County on the Walton-Holmes county line, 8 miles northeast of DeFuniak Springs, Florida. The lake basin is of Alum Bluff group origin, deposited during the Miocene times, as described by Vernon (1942).

The littoral zone is comprised of a dense entanglement of vegetation including; pickerelweed (*Pontederia cordata*); water lily (*Nymphaea sp.*); water milfoil (*Myriophyllum heterophyllum*) and several species of algae. Bordering the lake is a woodland climax of Pinus-Quercus association (Fig. 1). The dominant species present are; yellow pine, (*Pinus echinata*); red oak (*Quercus falcata*); white oak (*Quercus alba*); and laurel oak (*Quercus laurifolia*). Extending into the littoral zone is a stand of bald cypress (*Taxodium sp.*).

Fig. 1. A photograph of Lake Cassidy showing the heavy vegetative growth bordering the lake.

The lake bottom consists of silt overlying sand and has an irregular contour. The deepest areas are in the southeastern section where the maximum depth is approximately 32 feet. (Fig. 2).

Limnologists have postulated several methods for the classification of lakes. I have chosen Whipple's (1927) physical classification to further describe this lake. Lake Cassidy is a tropical lake

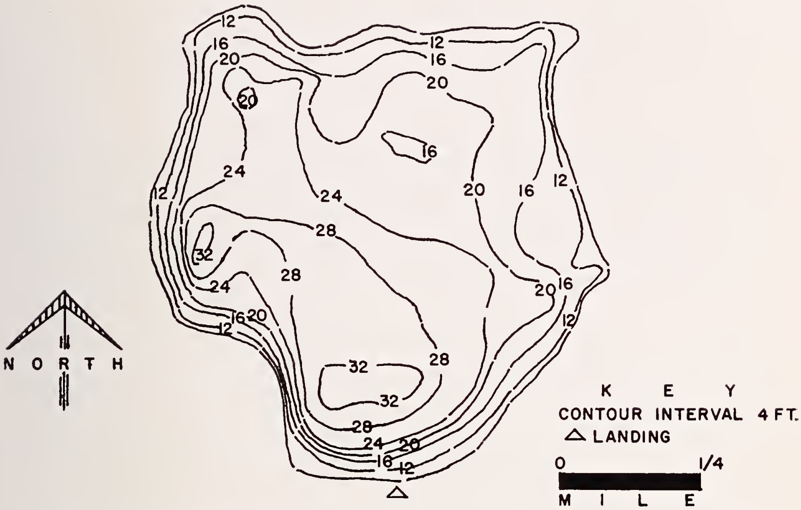

Fig. 2. A map indicating the contour of the lake. (Florida Game and Fresh Water Fish Comm. 1960)

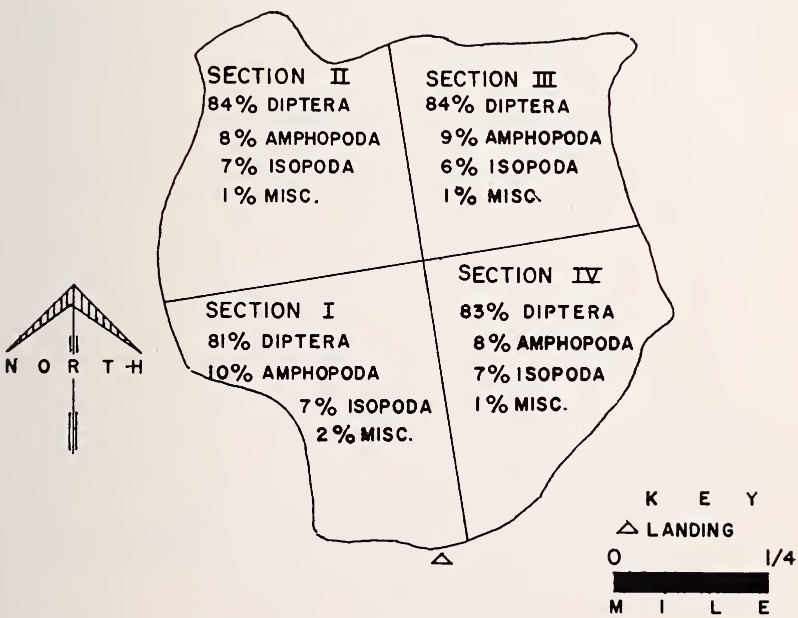

Fig. 3. A comparison of fauna collected in four sections of Lake Cassidy during the standing crop study. (Percent by numbers)

of the third order or by definition, a lake in which the temperature of the bottom water is very similar to that of the surface water.

Methods and Materials

The preliminary survey of the biology and chemistry of Lake Cassidy was completed in June, 1960. The lake was divided into 4, approximately equal sections and invertebrate organisms were collected from each section. In comparing the invertebrates from these 4 sections, no significant difference in variety or number was found. (Fig. 3).

Chemical analyses, done during this phase of the study, showed minor variations at field stations sampled. This chemical similarity indicated each station did not warrant individual consideration. Instead, chemical data collected at various depths, from a single station would be of greater value in the seasonal succession study to follow.

Since Sections I, II, III and IV were biologically and chemically similar, only Section I was selected for study during the seasonal investigation.

Section I is approximately 55 acres, or one-quarter of the lake. The maximum, normal depth is 32 feet, the bottom consists of a layer of silt overlying sand.

Biological bottom samples were collected at each of 10 field stations in this section. These stations were arranged to effectively sample the sublittoral and littoral zones; they range in depth from 6 to 32 feet. (Fig. 4).

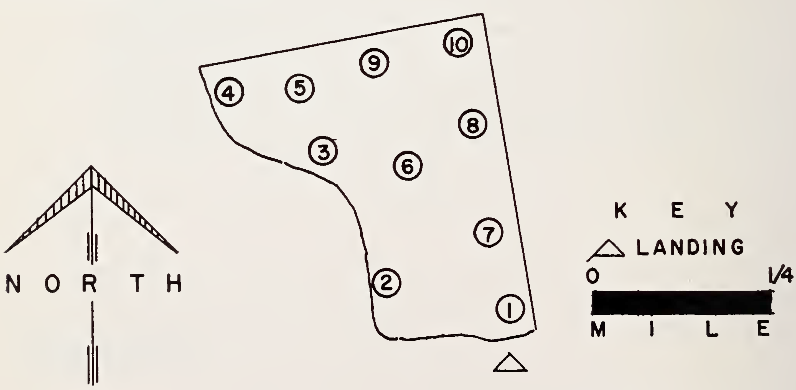

Fig. 4. Section I of Lake Cassidy, showing the location of field sampling stations.

The bottom organisms were collected with a standard 6 x 6 inch Ekman dredge, (Welch, 1948). Animals were preserved and later returned to the laboratory for quantitative and qualitative analyses.

Organisms were separated and classified according to Pennak (1953) and to modified keys for the identification of Diptera larvae (Beck, 1960); Ephemeroptera (Berner, 1950); Trichoptera (Ross, 1944); and Odonata (Byers, 1930). In addition specific identification of certain Ephemeroptera and Odonata was made by Dr. L. Berner and Dr. M. J. Westfall, Jr., respectively.

To aid in quantitative analyses the total number of organisms from each Ekman dredge sample are expressed as number of organisms per square meter.

Water samples to be used in the determination of chemical data were collected at 6 foot intervals from station 10. The pH, dissolved oxygen and temperature were determined in the field. Other analyses including determination of acidity, alkalinity, nitrogen (ammonia), carbon dioxide, total dissolved solids, hardness, color and turbidity were made in the laboratory. All analytical procedures followed the eleventh edition of Standard Methods for the Examination of Water and Waste Water. (1960).

Faunal Habitat and Distribution

Invertebrate organisms collected in the open water or sublittoral zone of section I were abundant in number but few in variety; the opposite was true of the littoral zone. These faunal differences are correlated with littoral vegetation (Reid 1950) and are shown in Table I.

Fauna of the littoral zone was dominated by Diptera larvae, but several other species of insects, crustaceans and aquatic worms were also collected.

Invertebrate variety decreased as bottom sampling approached the sublittoral zone. Dominant species of the sublittoral bottom were the phantom midge larvae, (*Chaoborus punctipennis*) the bloodworm (*Chironomus dux*) and two other midge larvae (*Procladius culiciformis,* and *Clinotanypus sp.*). The only other larvae collected in this area were *Pentaneura carnae; Pentaneura sp. D; Cryptochironomus fuluus* and *Culicoides spp.* The few times they were collected indicated their limited numbers in deep water.

TABLE 1

THE INVERTEBRATE ORGANISMS OF LAKE CASSIDY COLLECTED IN THE LITTORAL AND/OR SUBLITTORAL ZONE OF SECTION I.

LITTORAL ZONE	SUBLITTORAL ZONE
PLATYHELMINTHES	
Tubellaria (flatworms)	
Dugesia tigrina (Girard)	
ANNELIDA	
Oligochaeta (aquatic earthworms)	
Limnodrilus spp.	*Limnodrilus spp.*
	Lumbriculidae (family)
Hirudinea (leeches)	
Helobdella stagnalis (Linn.)	
ARTHROPODA	
Crustacea	
Isopoda (aquatic sowbugs)	
Asellus spp.	
Amphopoda (scuds, sideswimmers)	
Hyalella azteca (Saussure)	
Decapoda (crayfish, shrimp)	
Palaemonetes paludosus (Gibbes)	
Arachnoidea	
Hydracarina (water mites)	
Arrenurus spp	*Hydrachna spp*
Hydrachna spp	*Limnesia spp*
Limnesia spp	
Hexapoda or Insecta	
Ephemeroptera (mayflies)	
Caenis diminuta (Walker)	*Hexigenia munda marilandica* (Traver)
Ephemerella trilineata (Berner)	
Hexigenia munda marilandica (Traver)	
Paraleptophlebia bradleyi (Needham)	
P. volitans (McDunnough)	

TABLE 1—Continued

THE INVERTEBRATE ORGANISMS OF LAKE CASSIDY COLLECTED IN THE LITTORAL AND/OR SUBLITTORAL ZONE OF SECTION I.

LITTORAL ZONE	SUBLITTORAL ZONE
Odonata Anisoptera (dragonflies)	
Celithemis bertha (Williamson)	
C. ornata (Ramber)	
Gomphus cavillaris (Needham)	
Libellula incesta (Hagen)	
Pachydiplax longipennis (Burmeister)	
Tetragoneuria sp.	
Zygoptera (damselflies)	
Argia translata (Hagen)	
Enallagma traviatum (Selys)	
Ischnura posita (Hagen)	
Neuroptera (spongilla flies)	
Climacia areolaris (Hagen)	
Trichoptera (caddis flies)	
Leptocella sp.	
Oecetis sp.	
Oxyethira sp.	
Polycentropus interruptus (Banks)	
Lepidoptera Pyralididae (aquatic caterpillars)	
Nymphula sp.	
Coleoptera (beetles)	
Stenelmis lateralis (Sand)	
Diptera (flies, mosquitoes, midges) (Tanypodinae)	
Clinotanypus sp.	*Clinotanypus sp.*
Pentaneura sp A (Beck)*	*Pentaneura carnea* (Fabricius)
P. carnea (Fabricius)	*P. sp D* (Beck)
P. sp D (Beck)	*Procladius culiciformis* (Linn.)
P. illinoense (Malloch)	
P. monilis (Linn.)	
P. pilosella (Loew)	

* Species designated by a letter have not been formally described by Beck for publication.

TABLE 1—Continued

THE INVERTEBRATE ORGANISMS OF LAKE CASSIDY COLLECTED IN THE LITTORAL AND/OR SUBLITTORAL ZONE OF SECTION I.

LITTORAL ZONE	SUBLITTORAL ZONE
(Chironomini)	
Chironomini sp L (Beck)	
Chironomus (Chironomus) *decorus* (Joh.)	*Chironomus* (Kiefferulus) dux (Joh.)
Cryptochironomus sp.	
Cryptochironomus fuluus (Johannsen)	*Cryptochironomus fuluus* (Joh.)
Endochironomus (Endochironomus) *nigricans* (Joh.)	
Glyptotendipes sp.	
G. sp A. (Beck)	
G. sp B. (Beck)	
G. (Phytotendipes) *lobiferus* (Say)	
G. (Phytotendipes) *paripes* (Edwards)	
Harnischia sp.	
Harnischia sp G. (Beck)	
Lauterborniella varipennis (Coquillett)	
Limnochironomus sp.	
Microtendipes pedellus var. aberrans (Joh.)	
Polypedilum sp.	
P. (Tripodura) *halterale* (Coquillett)	
P. (Polypedilum) *illinoense* (Malloch)	
Polypedilum (Tripodura) *scalaenum* (Schrank)	
Pseudochironomus fulvientris (Joh.)	
Stictochironomus devinctus (Say)	
(Tanytarsini)	
Atanytarsus sp A (Beck)	
A. tanytarsus sp C (Beck)	
Rheotanytarsus sp A (Beck)	
R. exiguus (Joh.)	
Tanytarsus sp.	
Tanytarsus sp A (Beck)	
Tanytarsus sp B (Beck)	
(Chaoborinae)	
	Chaoborus punctipennis (Say)
(Ceratopodonidae)	
Culicoides spp.	*Culicoides spp.*
(Tabanidae)	
Chrysops sp.	

In addition to these dipterous larvae, the burrowing mayfly (*Hexigenia munda marilandica); aquatic earthworms* (*Limnodrilus sp.*) and several species of water mites (Hydracarina) inhabited this area.

The littoral and sublittoral zones are also inhabitated by several species of fish. These fishes may have a very important affect on invertebrate populations.

Fish Population

Although many macroscopic invertebrates prey upon one another, the major predators of these organisms are fishes, (Ball, 1952). In 1957, a fish population investigation was conducted by Byrd, and Wilson using four major collecting devices:

1. Fishtox (1 gallon)
2. 50 foot Cotton Trammel net
3. 100 foot Nylon Gill nets
4. Rotenone (1 gallon)

Results of this study indicated Lake Cassidy had a trend toward over-population of bluegill. The food of the bluegill consists largely of insects and their larvae, especially mayflies, damselflies and midges (Harlan & Speaker, 1956). They feed upon these aquatic invertebrates during most of the active growing season (Ball, 1948) but turn to plant food to supplement or replace the animal food during the midsummer season, when the supply of invertebrates reaches its lowest point of the year.

Table 2 contains a list of the fishes collected (Byrd and Wilson, 1957). Only 2 of the 14 species collected are strictly non-bottom feeders.

Seasonal Succession

Factors including the lake bottom, vegetation and fish, affecting invertebrate population have been briefly mentioned. Now let us look at the physical and chemical changes of the water which affect invertebrate population.

Many chemical and physical changes took place in Lake Cassidy during the winter months. The major changes were that of temperature and light. As the length of day and angle of sun incidence decreased the waters became cooler. Bottom water temperatures dropped from 21° to 13° C in a period of one month (November to December). The pH remained almost constant at

5.4 and dissolved oxygen content began to rise as temperatures fell; oxygen tension increased from 7.1 to 9.3 mg/1. The rapid drop in water temperature was followed by a sharp increase in invertebrates the next month. The number of organisms in December was 3,666 per square meter, while organisms collected in January totaled 6,946 per square meter. Though population doubled in January the recorded number of species differed only slightly. There were 33 species of insects collected in December and 31 in January. Species of the Classes Turbellaria, Oligochaeta, Crustacea, and Arachnoidae were similarly comparable. This rise in population was due therefore to numerical increases of certain insects and crustaceans, rather than the presence of new species. The scud (*Hyalella azteca*) increased at a ratio of 4 to 1, while in the insect group, the midge larvae (*Harnischia sp G; Microtendipes pedellus aberrans;* and *Tanytarsus sp.*) contributed most to this increase.

TABLE 2

THE FISHES OF LAKE CASSIDY

1.	Yellow Catfish	*Ameiurus natalis* (Le Sueur)
2.	Northern Largemouth Bass	*Micropterus salmoides salmoides* Lacepede
3.	Warmouth	*Chaenobryttus coronarius* (Bartram)
4.	Bluegill	*Lepomis macrochirus purpuresceus* Cope
5.	Dollar Sunfish	*Lepomis marginatus* (Holbrook)
6.	Tadpole Madtom	*Noturus mollis* (Hermann)
7.	Star-headed Topminnow	*Fundulus notti notti* (Agassiz)
8.	Eastern Mosquito Fish	*Gambusia affinis holbrooki* (Girard)
9.	Everglade Pigmy Sunfish	*Elassoma evergladei* Jordan
10.	Florida Swamp Darter	*Etheostoma barratti* (Holbrook)
11.	Spotted Gar	*Lepisosteus* sp.
12.	Eastern Chubsucker	*Erimyzon sucetta* (Lacepede)
13.	Southern Brown Bullhead	*Ameiurus nebulosus marmoratus* (Holbrook)
14.	Bowfin	*Amia calva* (Linnaeus)

After the January maximum, invertebrate population began to decrease slowly until spring. The early spring collections showed a sharp decline in population. The number of recorded organisms decreased from 6,029 to 4,910 per square meter from February to March. During this period, water temperatures increased rapidly from 11° to 16° C and other environmental factors were affected to a lesser degree.

Population increased slightly in April because of an increase in sublittoral organisms. However, May samples showed a 1,777 organism per square meter reduction. During this period water temperature increased to 20° C. and bluegill fry hatched and began feeding on aquatic insect larvae. (Harlan & Speaker, 1956) Concurrently, several insect casts were seen on the surface of the water indicating a recent emergence. The increased water temperature was probably an important factor in the occurrance of these two events.

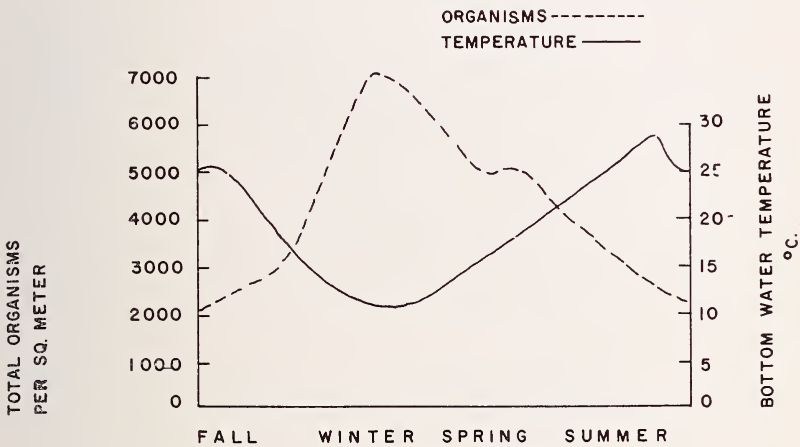

Fig. 5. Seasonal fluctuations of temperature and invertebrate populations.

Another observed factor which seemed to have direct relationship with the organism reduction was dissolved oxygen. Dissolved oxygen is largely dependent on temperature conditions (Welch, 1952 p 97) but it is also affected by other variables. In May the dissolved oxygen began to decrease rapidly and reached a low of 2.0 mg/1 by July. This was only 24.5% saturation. Oxidation of the organic matter on the lake bottom probably caused the reduction and as oxygen demand was met the percent saturation increased. The following month, August, oxygen increased yet invertebrates continued to decrease until their low of 2,393 per square meter in September. Therefore, the close relationship between oxygen changes and population decrease was probably only a coincidence.

The correlation between water temperature and invertebrate population remained constant. As the summer days became longer and the sun's light and heat became more intense, the water temperature slowly increased. This rise in water temperature was accompanied by a steady decrease of invertebrates. Figure 5 shows the inverse correlation between water temperature and invertebrate population.

Summary and Conclusions

This study has shown the seasonal changes of selected factors in a northwestern Florida Lake and the affects of these changes on certain bottom organisms.

Vegetation in the littoral zone remained green throughout the year providing thick entanglement for invertebrate life. Greater numbers of species inhabit this area and these organisms indicated environmental conditions of the lake shoreline.

Benthic invertebrates of the sublittoral zone had but a single habitat, the mucky bottom. This area was subjected to adverse conditions such as reduced oxygen tension, but the invertebrates seemed to be quite tolerant. Midge larvae, aquatic earthworms, water mites and a burrowing mayfly were the only invertebrates collected from this area.

The pH remained acid throughout this investigation, it ranged from 5.1 to 5.9. Acidity was attributed to leeching of tannic acid from vegetation in the lake and surrounding woodland. The invertebrate population changes did not follow pH fluctuation.

Fluctuation in other chemical data including acidity, alkalinity, nitrogen (ammonia), dissolved solids and hardness were diminutive. No correlation was apparent between these chemical factors and invertebrate fluctuations.

Turbidity and color were less than 1 unit except for a non-settling layer of cloudy water which lay just above the bottom. This thin layer was due largely to fine particles, more or less, permanently suspended in the water, as explained by Jackson and Starrett (1959). Benthic organisms were constantly subjected to this environmental factor and it did not appear to have any major affect on their existence.

No time during the year was there extended periods of precipitation or drought, and the depth of the water remained relatively constant. The only physical factors that varied appreciably were temperature and light.

During the winter, water temperature dropped as the days became shorter and the direct sunlight decreased. A minimum of 11° C prevailed on the lake bottom during January and February. This decrease in temperature was accompanied by an increase in the bottom invertebrate population. In contrast, as the warm summer months approached, water temperatures increased and invertebrates decreased. Water temperature reached a maximum late in the summer; and this corresponded with the invertebrate minimum.

Throughout the year, the number of invertebrates rose and fell with temperature fluctuations, yet the variety of organisms remained relatively constant.

It is highly doubtful that any one factor was completely responsible for population differences. However, population fluctuations were more closely correlated with water temperature than any other observed factor.

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